

(12) UK Patent Application

(19) GB

(11) 2 259 190 A

(43) Date of A publication 03.03.1993

(21) Application No 9118739.3

(22) Date of filing 02.09.1991

(71) Applicant  
International Business Machines Corporation  
  
(Incorporated in the USA - New York)  
  
Armonk, New York 10504, United States of America

(72) Inventors  
Malcom Dye  
Terence Keith Gibbs  
Ian Douglas Mercer  
Graham Luck

(74) Agent and/or Address for Service  
F N Blakemore  
IBM UK Ltd, Intellectual Property Dept,  
Mailpoint 110, Hursley Park, Winchester,  
Hampshire, SO21 2JW, United Kingdom

(51) INT CL<sup>5</sup>  
H01F 27/34, H04N 3/16

(52) UK CL (Edition L)  
H1T T1C T7A7 T7A8  
U1S S2206 S2284

(56) Documents cited  
GB 1424037 A GB 1066879 A GB 0867999 A  
GB 0828405 A EP 0243862 A2

(58) Field of search  
UK CL (Edition K) H1T  
INT CL<sup>5</sup> H01F, H04N

(54) Non-linear inductors

(57) A non-linear inductor for a CRT line timebase circuit comprises a bobbin 40 carrying an inductive coil 41 and a first permanent magnet 42 adjacent the coil 41. A second permanent magnet 200 is positioned and oriented relative to the first magnet 42 in such a manner that the magnetic field generated by the non-linear inductor is substantially reduced. Because the second magnet 200 is integral, the non linear inductor occupies the same printed circuit board area as a conventional non linear inductor. Furthermore, because the second magnet 200 is oriented to substantially cancel the magnetic field, no additional magnets are required for deflecting the magnet field away from the CRT.

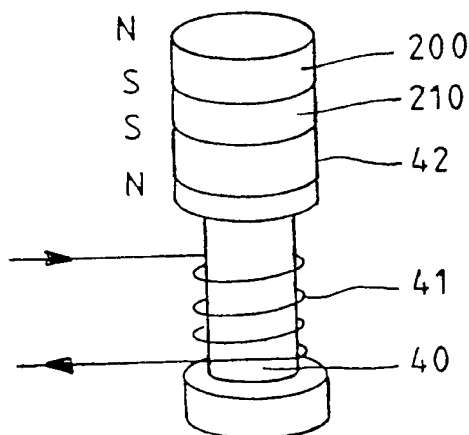
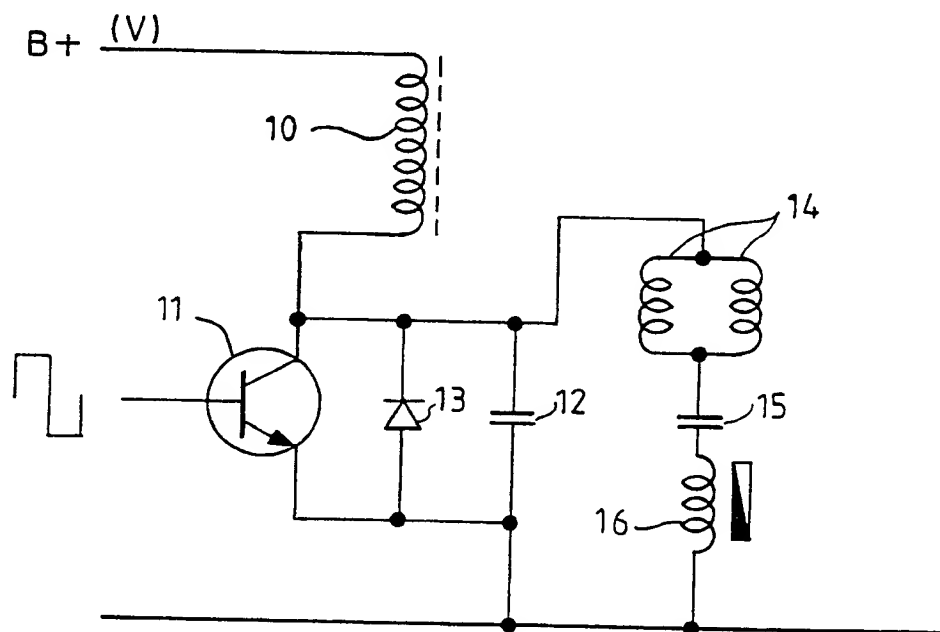


FIG. 8

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

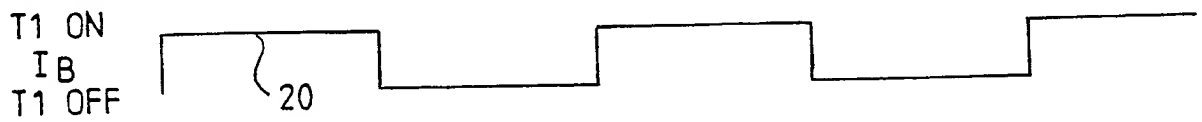
FIG. 1

BASE  
CURRENT

T1 ON

$I_B$

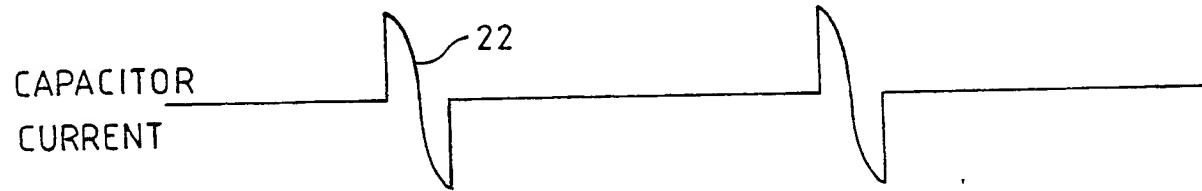
T1 OFF



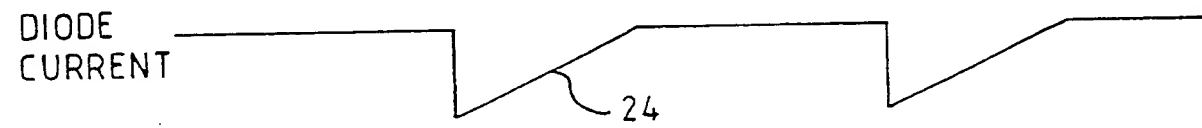
SWITCH  
CURRENT



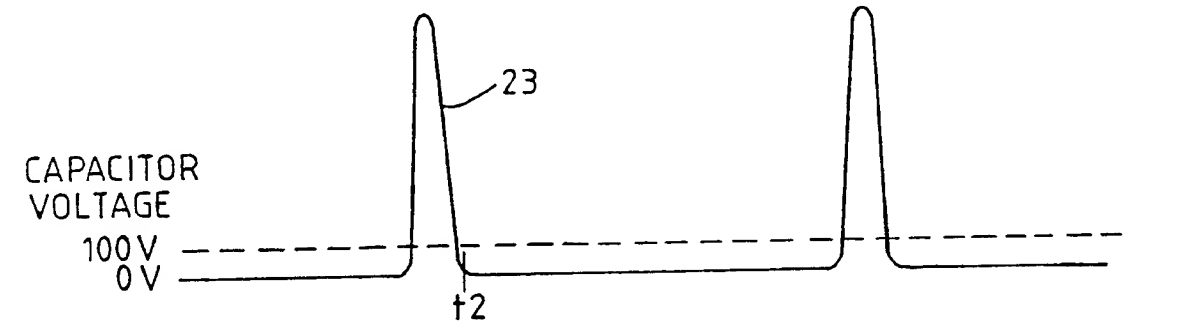
CAPACITOR  
CURRENT



DIODE  
CURRENT



CAPACITOR  
VOLTAGE



INDUCTOR  
CURRENT

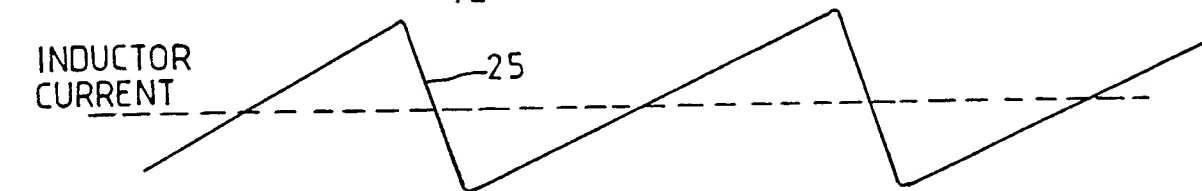


FIG. 2

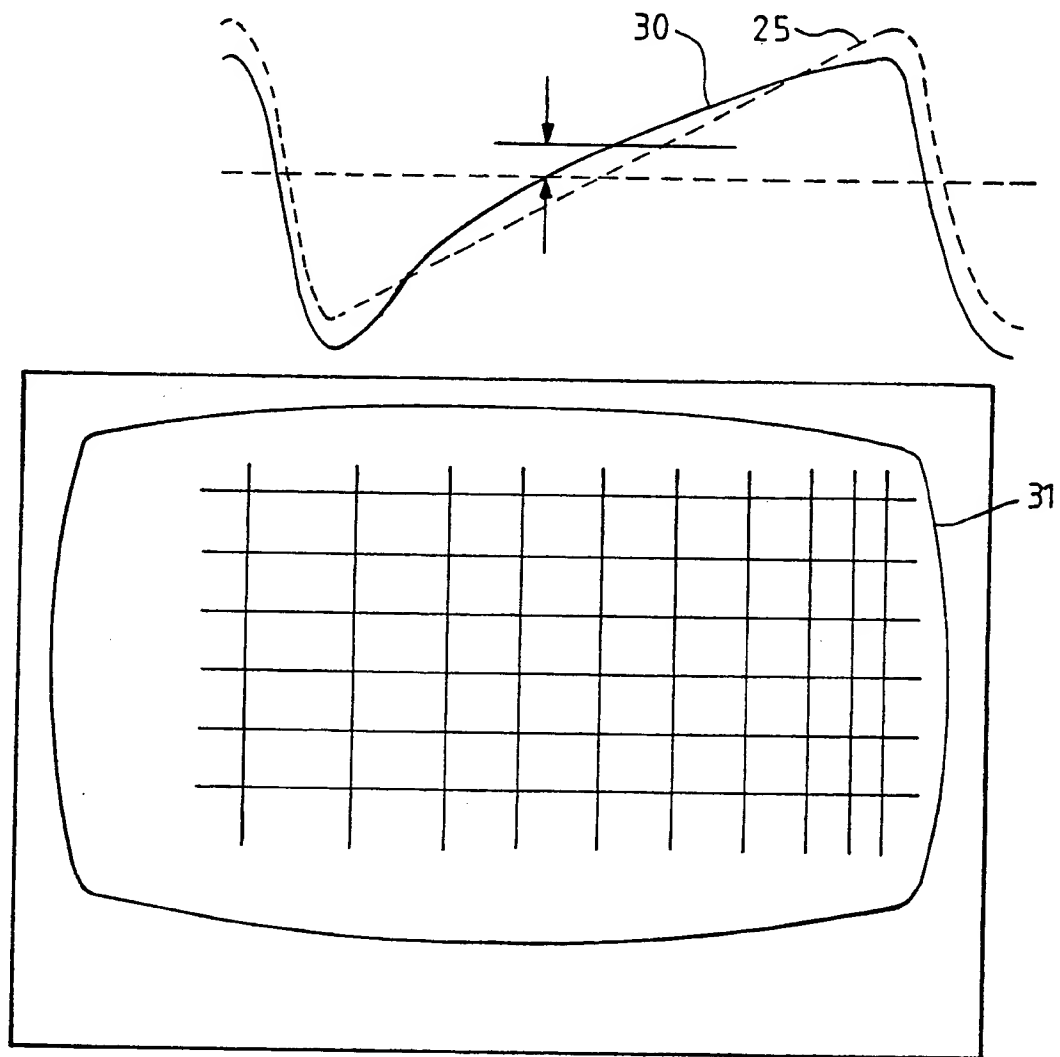


FIG. 3

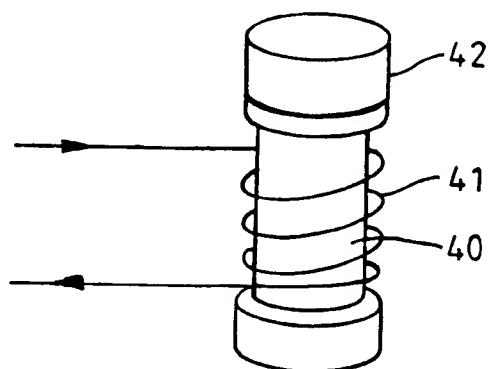
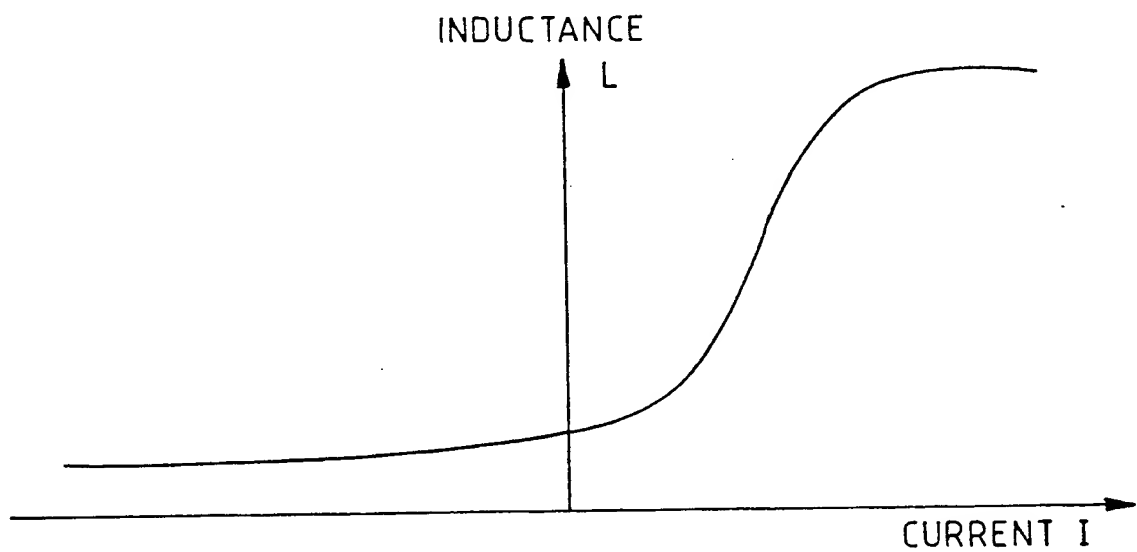
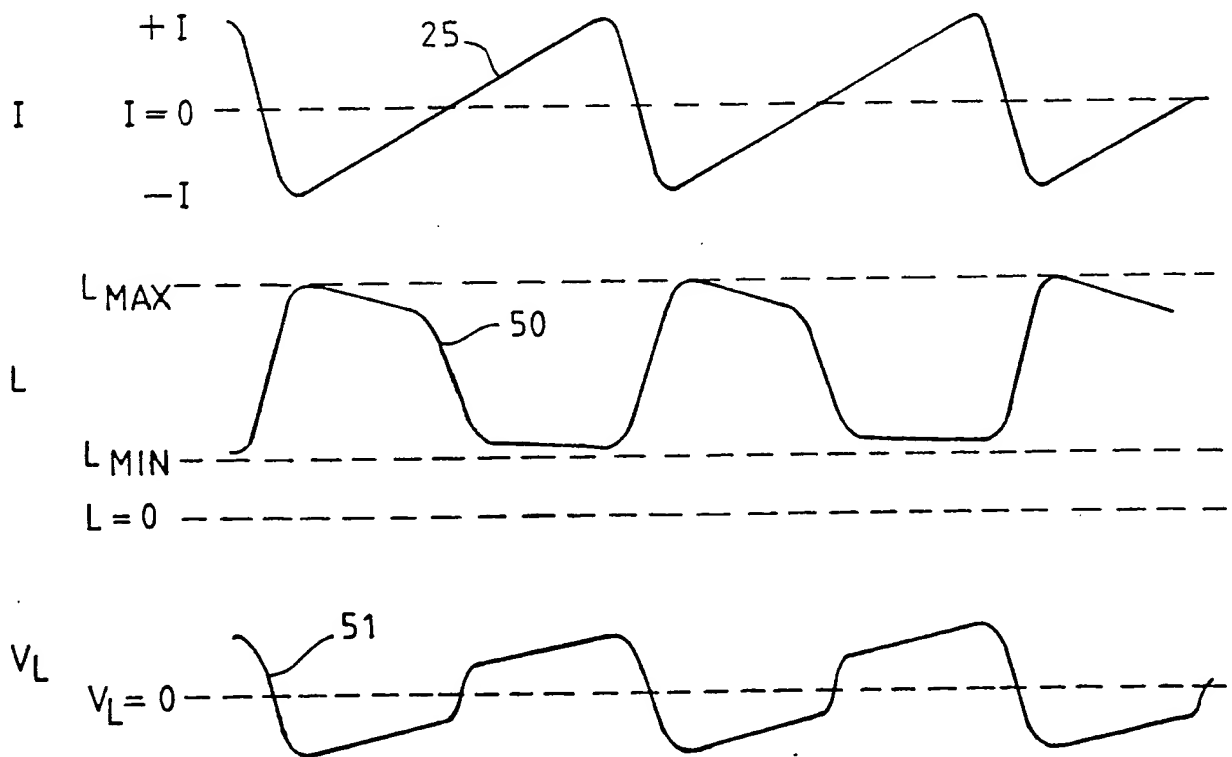


FIG. 4

FIG. 5FIG. 6

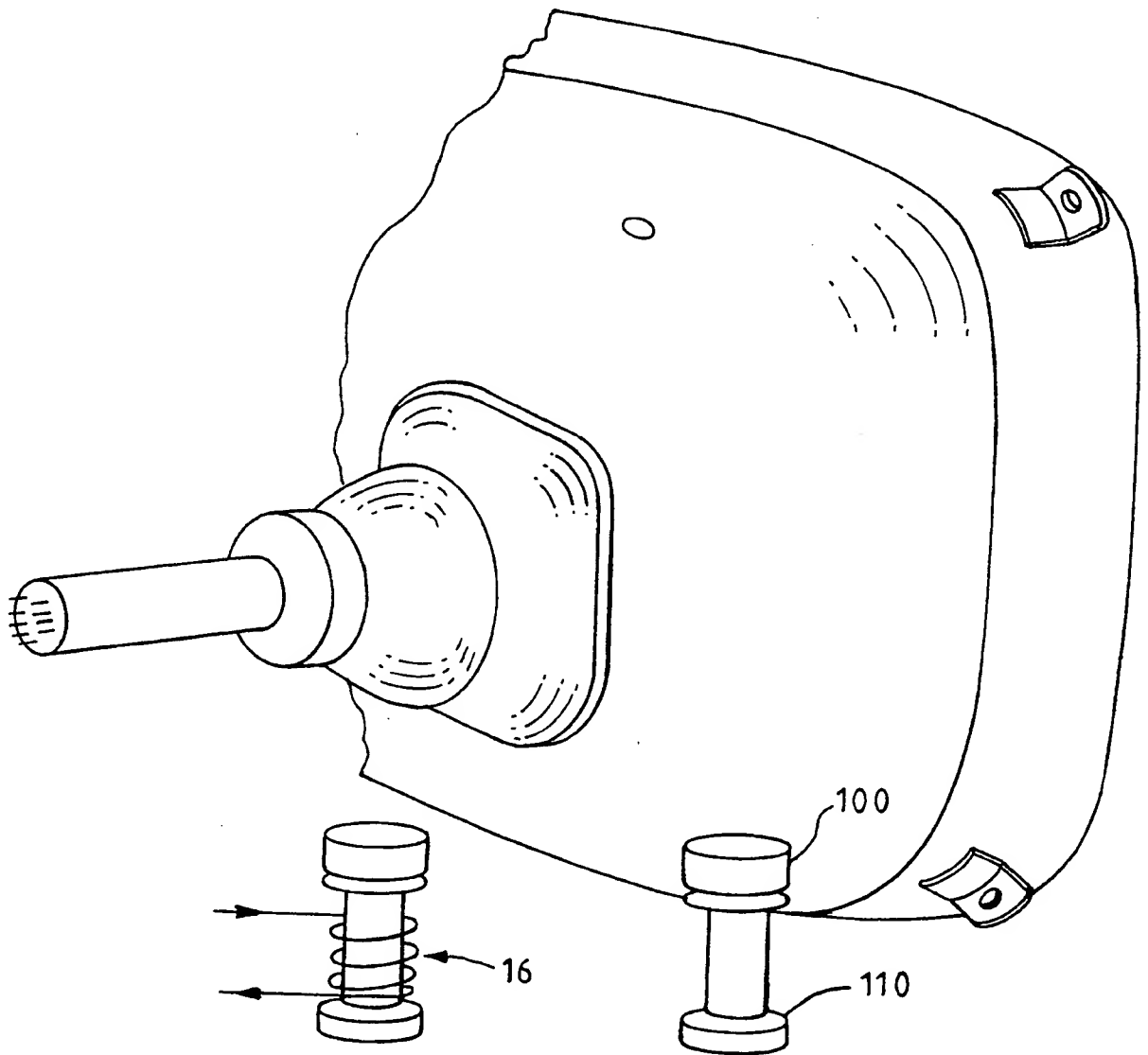


FIG. 7

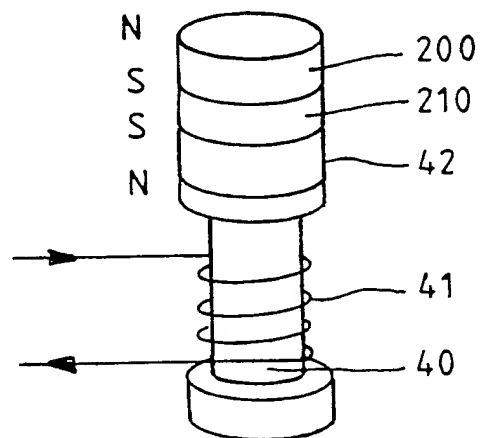


FIG. 8

## NON-LINEAR INDUCTOR WITH MAGNETIC FIELD REDUCTION

The present invention generally relates to a non-linear inductor with magnetic field reduction for use in a raster-scanned CRT display such as a television receiver or a computer visual display unit.

A raster-scanned CRT display comprises a line timebase circuit for generating a sawtooth deflection current in a pair of electromagnetic line scan coils. The deflection current energises the coils to produce a time variant magnetic deflection field. The deflection field scans one or more electron beams from one side of the CRT screen to the other side during a line scan period and rapidly returns the electron beam during a retrace or flyback period to the start of the next line of the raster to be scanned. The line timebase circuit typically comprises an inductor connected in series with a high voltage solid state switch such as a bipolar transistor. During the line scan period, the switch is closed and current flows through the inductor and switch from a high voltage DC supply (typically 100V) to ground. The current flowing through the inductor and the current flowing in the scan coils increase at a rate proportional to the voltage across the inductor. During the flyback period, the switch is opened. The current in the inductor rapidly reverses and a back Electromotive Force (EMF) or "flyback pulse" is generated across the inductor by the collapsing magnetic field in the inductor. The flyback pulse is controlled by a tuning capacitor connected across the switch. The back EMF dissipates causing the current in the scan coils to rapidly reverse. The electron beam is thus deflected rapidly back to the start of the next scan line.

Ideally, the deflection coils would be pure inductances. In practise however, the coils have a DC resistance. The resistance causes an asymmetric non-linearity in the sawtooth deflection current. The non-linearity gives rise to objectionable asymmetric distortion of an image displayed on the CRT screen. The asymmetric distortion is a



function of the inductance to resistance ratio of the deflection coils and therefore varies proportionally with frequency.

In a typical CRT display, the asymmetric non-linearity is corrected by connecting a non-linear inductor in series with the deflection coils. The non-linear inductor typically comprises a permanent magnet positioned adjacent an inductive winding. The inductance of the non-linear inductor varies about an operating point as a function of the current flowing through the winding. Some non-linear inductors comprise a moveable magnet which can be set in position during a manufacturing process step. The moveable magnet permits manual adjustment of the polarity of the magnet relative to the winding, and therefore changes the operating point of the inductor. In a colour CRT display, low level magnetic correction fields are arranged around the neck of the CRT to optimise electron beam convergence and colour purity. The magnetic field from the magnet can interfere with these correction fields and thus degrade picture quality. To minimise such degradation, the non-linear inductor is usually located as far away from the CRT as possible. However, because CRT displays are becoming smaller in size, and CRT resolution is increasing, it is becoming increasingly difficult to prevent the stray field from the non linear inductor from interfering with the correction fields.

Such interference may be prevented by magnetically screening the non linear inductor from the CRT. However, this is both costly and space consuming. Alternatively, as described later with reference to Figure 7 of the accompanying drawings, another magnet may be located on in the vicinity of the non linear inductor to deflect the magnetic field from the non linear inductor away from the CRT. However, the deflection provided by the other magnet is very sensitive to its position relative to the CRT and the non linear inductor. Therefore, printed circuit board space must be set aside for accommodating the other magnet.

In accordance with the present invention, there is now provided a non-linear inductor comprising: a bobbin carrying an inductive coil; a first permanent magnet adjacent the coil; and a second permanent magnet positioned and oriented relative to the first magnet in such a manner that the magnetic field generated by the non-linear inductor is substantially reduced.

Because the second magnet is oriented to substantially cancel the magnetic field, no additional magnets are required for deflecting the magnet field away from the CRT.

Viewing the present invention from a second aspect, there is provided a non-linear inductor comprising: a bobbin carrying an inductive coil; a first permanent magnet adjacent the coil; and a second permanent magnet positioned and oriented relative to the first magnet in such a manner that the magnetic field generated by the first magnet is opposed to the magnetic field generated by the second magnet.

Because the second magnet is integral, a non linear inductor of the present invention occupies the same printed circuit board area as a conventional non linear inductor.

A preferred embodiment of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a circuit diagram of a line timebase circuit for a CRT display of the prior art.

Figure 2 is a waveform diagram corresponding to the line timebase circuit shown in Figure 1.

Figure 3 is a waveform diagram illustrating a non-linear deflection current and a corresponding image geometry distortion.

Figure 4 is an isometric view of a non linear inductor of the prior art.

Figure 5 is a graph illustrating the inductance of the non-linear inductor varying as a function of current flowing through the non-linear inductor.

Figure 6 is a waveform diagram illustrating the inductance of the non-linear inductor varying as a function of a sawtooth deflection current flowing through the non-linear inductor.

Figure 7 is an isometric view of conventional apparatus for deflecting the magnetic field generated by the non linear inductor shown in Figure 4 away from a CRT.

Figure 8 is an isometric view of a non-linear inductor of the present invention.

Figure 1 shows an example of line timebase or "flyback" circuit comprising an inductor 10 connected between a high voltage (100V) supply rail V and the collector of a bipolar transistor switch 11. The emitter of transistor 11 is connected to ground. A capacitor 12 is connected between the collector of transistor 11 and ground and a diode 13 is connected across capacitor 12 for conducting current from ground to the collector of transistor 11. A pair of line deflection coils 14 are also connected to the collector of transistor 11. The inductance of coils 14 is much smaller than that of inductor 10. An S correction capacitor 15 is connected between coils 14 and a non-linear inductor 16. Capacitor 15 compensates for a symmetrical linearity error produced by a geometrical relationship between deflection angle and electron beam displacement on a CRT screen. The capacitance of capacitor 15 is much larger than that of capacitor 12. Non-linear inductor 16 is connected between capacitor 15 and ground.

Referring now to Figure 2, in operation transistor 11 is turned on and off with a fifty per cent duty cycle by an alternating square wave base current 20. When transistor 11 is turned on, current 21 flows from the supply rail through inductor 10 to ground through transistor 11. The current increases at a rate proportional to the voltage  $V$  across inductor 10. When transistor 11 is turned off, current 22 flows through inductor 10 and into capacitor 12. Voltage 23 across capacitor 12 rises as capacitor 12 charges up thus reversing the voltage across inductor 10. The current in inductor 10 thus falls at a faster rate. Diode 13 prevents the voltage across capacitor 12 from going negative at  $t_2$  to prevent the voltage across capacitor 12 from oscillating. Current 24 now flows from ground through inductor 10 to the supply rail through diode 13 rather than out of capacitor 12. Therefore, over a full cycle, inductor 10 carries a sawtooth current 25. A current similar to sawtooth current 25 is therefore drawn through coils 14.

Coils 14 are AC coupled to ground by capacitor 15 to remove any DC offset from the current in coils 14. Furthermore, the deflection current generates a parabolic voltage across capacitor 15 which is the integral of the deflection current. The parabolic voltage in turn modulates the deflection current in coils 14 to provide cancellation of the symmetrical linearity error.

Referring now to Figure 3, the ideal deflection current with no S correction or linearity correction applied is a symmetrical, linear sawtooth current 25. However, in practise, the deflection current is an asymmetrical, non-linear sawtooth current 30. Asymmetrical non-linearities are produced in the deflection current by frequency dependent energy losses from complex parasitic impedances within the circuit. The asymmetrical deflection current 30 causes an offset, non-linear line deflection of the electron beam. This produces a distorted image illustrated by crosshatch 31.

With reference to Figure 4, an example of non linear inductor 16 comprises a dumb-bell shaped ferrite core 40 carrying an inductive coil 41. A permanent magnet 42 is bonded to the core 40. Magnet 42 causes inductance  $L$  of inductor 16 to vary as a non-linear function of current  $I$  flowing in coil 41. Figure 5 illustrates graphically the non-linear function of inductor 16.

Referring now to Figure 6, waveform 50 illustrates the variation of inductance  $L$  between maximum and minimum limits  $L_{max}$  and  $L_{min}$  in response to a sawtooth current  $I$  25 flowing in coil 41. Thus, the impedance of inductance 16 at a particular frequency also varies between maximum and minimum values. A voltage signal 51 is therefore dropped across the inductor.

Referring back to Figure 1, coils 14 and inductor 16 form a potential divider. In operation, the sawtooth deflection current flowing through coils 14 generates voltage signal 51 across inductor 16. Voltage signal 51 amplitude-modulates capacitor voltage 23 in such a way as to cancel the effects of the parasitic impedances on the deflection current.

Referring now to Figure 7, as hereinbefore mentioned, the magnetic field from the non-linear inductor 16 may be deflected away from the CRT by placing another magnet 100 on a ferrite core 110 in the vicinity of the non-linear inductor. It will however be appreciated from Figure 7 that the deflection provided by the other magnet is very sensitive to its position relative to the CRT and the non linear inductor. It will also be appreciated that printed circuit board space must be set aside for accommodating the other magnet.

Referring now to Figure 8, an example of a non-linear inductor of the present invention comprises a dumb-bell shaped ferrite core or bobbin 40 carrying an inductive coil 41. A first permanent magnet 42 is bonded to one end of the bobbin 40. Magnet 42 causes inductance  $L$  of

inductor 16 to vary as a non-linear function of current  $I$  flowing in coil 41. A second permanent magnet 200 is located above the first magnet 42 in such a manner that one pole of the second magnet 200 faces a like pole of the first magnet 16. The second magnet 200 is spaced from the first magnet 42 by an insulator 210 of invariant thickness. The magnet characteristics of the first and second magnets are substantially identical and the thickness of the insulator is determined so that the magnetic field generated by the non linear inductor in use is substantially cancelled by the second magnet. It will however be appreciated that, in other embodiments of the present invention, the magnetic strength of the second magnet may be less the magnetic strength of the first magnet but sufficient to reduce the magnetic field from the non-linear inductor to an acceptable level.

## CLAIMS

1. A non-linear inductor comprising: a bobbin 40 carrying an inductive coil 41; a first permanent magnet 42 adjacent the coil 41; and a second permanent magnet 200 positioned and oriented relative to the first magnet 42 in such a manner that the magnetic field generated by the non-linear inductor is substantially reduced.
2. A non-linear inductor comprising: a bobbin 40 carrying an inductive coil 41; a first permanent magnet 42 adjacent the coil 41; and a second permanent magnet 200 positioned and oriented relative to the first magnet 42 in such a manner that the magnetic field generated by the first magnet 42 is opposed to the magnetic field generated by the second magnet 200.
3. A line timebase circuit for a cathode ray tube display device, the circuit comprising a non-linear inductor as claimed in claimed 1 or claim 2.
4. A cathode ray tube display device comprising a line timebase circuit as claimed in claim 3.
5. A non-linear inductor substantially as hereinbefore described with reference to Figure 8 of the accompanying drawings.

Patents Act 1977  
Examiner's report to the Comptroller under  
Section 17 (The Search Report)

Application number

9118739.3

Relevant Technical fields

- (i) UK CI (Edition K ) H1T  
(ii) Int CL (Edition 5 ) H01F; H04N

Search Examiner

P CORBETT

Databases (see over)

- (i) UK Patent Office  
(ii)

Date of Search

20 MAY 1992

Documents considered relevant following a search in respect of claims

1-5

Category (see over)	Identity of document and relevant passages		Relevant to claim(s)
X	GB 1424037	(TAIYO YUDEN) see lines 78-112, page 2	1-4
X	GB 1066879	(PHILIPS) see Figure 3	1, 3, 4
X	GB 867999	(PHILIPS) see Figure 1	1-4
X	GB 828405	(PHILIPS) see lines 71-88, page 1	1, 3, 4
X	EP 0243862 A2	(EWD) see Figure 2	1-4

SF2(p)

1SF - c:\wp51\doc99\fil000365



Category	Identity of document and relevant passages	Relevance to claim(s)

### Categories of documents

**X:** Document indicating lack of novelty or of inventive step.

**Y:** Document indicating lack of inventive step if combined with one or more other documents of the same category.

**A:** Document indicating technological background and/or state of the art.

**P:** Document published on or after the declared priority date but before the filing date of the present application.

**E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.

**&:** Member of the same patent family, corresponding document.

**Databases:** The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).

